While some of the lost or damaged property will, very likely, be salvaged and repaired, the permanent losses in the district will, it is believed, be fairly represented by the foregoing total as the minor losses which were not reported will fully equal in value the property salvaged.—*Albert Brand, Meteorologist in Charge.*

Cairo, Ill., river district.

As applying to the months of December, 1917, and January, 1918, the winter of 1917–18 broke all records for heavy snow and low temperature. That is certainly true at Cairo and is probably true as applied to the lower Ohio and Tennessee Rivers.

At Cairo, Ill., December 9, 1917, a minimum temperature of —7° F. was recorded, the earliest date in that month when such severe temperature has occurred within the history of the station extending back 46 years; January 12, 1918, a minimum temperature of —16° occurred, equal to the lowest ever recorded here in any month; the mean temperature for December, 1917, 28.7°, was the lowest mean for that month ever recorded with the exception of 26.4°, in December, 1876; and the mean temperature for January, 1918, 21.0°, was about 4 degrees lower than that of any previous month, of record. Taking the two months, January, 1918, and the month preceding, combining their mean temperatures and dividing by 2, giving 24.8° as a basis of comparison, we had a mean daily average 4.6 degrees lower than that of any previous two consecutive months in the history of the station.

During the 62 days comprising December, 1917, and January, 1918, 35 days, had a maximum temperature below 32°.

As a consequence of the extremely cold weather ice formed in the lower Ohio and Tennessee Rivers in quantities never before recorded, and which the oldest inhabitants held neither in memory or tradition. January 12, 1918, people crossed the Ohio River at Cairo on the ice for the first time known, shore ice being about 18 inches in thickness, that in the channel probably about 2 inches.

The Mississippi in the vicinity of Cairo has previously been frozen solidly enough to drive cattle across, and no unusual records, relative to ice in that stream, were made, except that portion below Cairo where ice from the Ohio affected it.

The Ohio, below the mouth of the Wabash, closed about December 11, 1917, remained so for about 10 days, open until January 1, 1918, closed until February 3, when slight movements occurred, the final break-up occurring during the night of February 6–7; the maximum thickness of ice in the vicinity of Shawneetown, Ill., was 18 inches, and when the ice went out considerable gorging occurred, the river going above flood stage on the 8th, ice covering the fields on both sides of the river in that vicinity to a distance of one-half mile, breaking down fencing and barns; the fencing and buildings on this class of land are usually of flimsy structure and no considerable amount of damage resulted; however, a steamboat and three or four gasoline boats were destroyed, having a total valuation of $15,000.

In the Tennessee River, at Florence, Ala., gorges described as 70 feet high formed at the canal and a number of families removed from their houses as a precautionary measure, although no damage eventually occurred; the main channel of the stream did not close at any time, but seemed to almost close at intervals from January 12–16, 1918. Maximum thickness of shore ice was about 18 inches.

At Riverton, Ala., also, the main channel remained open, some small craft being damaged by floating ice, having a valuation of $1,000.

At Savannah, Tenn., a gorge formed about 8 feet in height and another gorge, upstream, was reported to have been 14 feet in height; the damage in that vicinity amounted to about $2,200 in all, lumber and buoys used in the operation of the local ferry boat being carried away by ice and flood.

Ice appeared at Johnsonville, Tenn., December 16, channel remained open until January 13 and 14, at which time it appeared possible to cross on foot, although the passage was not attempted by anyone; channel cleared January 15, with some slight damage to small boats, none being lost; the river became free from ice January 28–29.

The mouth of the Tennessee River, near Paducah, Ky., being reputed free from ice hazards, has been used as a winter anchorage for many steamboats, especially upper Mississippi River craft, for a number of years. The unprecedented ice conditions prevalent in the Tennessee and lower Ohio Rivers during the past winter made the situation there hazardous, and during the early morning of January 29, 1918, gorges carried away or sunk 8 steamboats, valued collectively at $350,000. The steamers *John L. Lowry* and *Joe Fowler* were not carried away with the ice, but were damaged to the extent of about $2,500; also, the ferryboat *City of Cairo*, in winter harbor at the mouth of the Tennessee, was damaged about $1,000.

At Metropolis, Ill., Joppa, Ill., and Mound City, Ill., considerable damage was done with the passing of the gorge January 29, but the full extent of damage has not been estimated.

At Cairo, two wharf boats were sunk, one wharf boat damaged by being pushed ashore by the ice, and all boats in the harbor were injured. The *Sprague*, the largest towboat plying in inland waters, was carried away but has since been recovered; the two wharf boats sunk had been in use a great many years, and were not of high intrinsic value, except as a matter of utility; the entire local damage to river craft probably amounted to $50,000.

At Hickman, Ky., on the Mississippi below Cairo, a steamboat belonging to the Mengel Box Co., was reported lost, value not estimated; and slight damages resulted from the passage of the gorge carrying away small craft and two houseboats at New Madrid, Mo.

A gorge at Columbus, Ky., held from late in December (Dec. 29, 1917) until January 30, 1918, breaking when the Ohio-Tennessee River gorges were forced upon it; foot passage between Kentucky and Missouri, across the frozen Mississippi, occurred at that point between January 10 and 15.

Taken altogether, ice conditions during the past winter throughout this river district were without precedent.—*R. T. Lindley, Meteorologist in Charge.*

THE MISSISSIPPI RIVER.

St. Paul, Minn., river district.

The channel closed at Robert Street bridge (location of gage) during the night of December 3-4, 1917; the thickness of the ice on Monday, December 10, was 7 inches; it increased to a maximum thickness of 20 inches on February 11. During the afternoon and night of Sunday, March 3–4 the ice ran out, and on the morning of March 4 the channel was open from the High Dam (about 3 miles above the mouth of the Minnesota River) to South St. Paul (about 5 miles below the gage). During the entire winter there was a narrow strip of open water along the shore on the gage side, from a large trunk sewer, about a half mile above the gage, to a mile below the gage.

The breaking up of the ice was gradual and without any rise of the water and therefore without any damage resulting.

At this date—March 20—the river is open from St. Anthony Falls, at Minneapolis, to near Hastings, and possibly farther down (20 miles).

It is expected that the ice in Lake Pepin will open in a few days.—*J. N. Ryker, Meteorologist in Charge.*

Dubuque, Iowa, river district.

The Mississippi River is now (Mar. 16, 1918) open at and near Dubuque. No gorges have formed, and the break-up has been wholly without damage. In spite of the severity of the past winter the thickest ice in this section was about 2 feet, which is not unusual. The heavy snow covering prevented extra heavy ice such as occasionually forms during a cold but "open" winter.

On the average the Mississippi River opens up here on March 15, and this year the opening was two days earlier than the average. Some of the rivers of this district, and also a portion of the Mississippi above Dubuque, are still frozen, but I think the break-up will be soon and without unusual incident throughout the river district.—*J. H. Spencer, Meteorologist in Charge.*

Davenport, Iowa, river district.

No gorges worthy of mention formed in the Davenport district during the winter of 1917–18. Notwithstanding its great thickness at the beginning of February, the ice broke up about two weeks earlier than usual and passed out quietly, without doing any particular damage. The river opened at Muscatine on March 1, at Davenport and Clinton on March 2, and at Le Claire on March 3.—*J. M. Sherier, Meteorologist in Charge.*

Keokuk, Iowa, river district.

The Mississippi River was open for 2 miles south of the Keokuk Dam during the entire winter owing to the discharge from the power house.

At Warsaw, Ill., 5 miles south, it was frozen, and teams were crossing on the ice until the middle of January.

By February 14 the ice had moved out from the lower Des Moines and from the Mississippi at Warsaw, gorging between Gregory and Canton, Mo. This gorge caused a rise of 3 feet at Warsaw, and the rise extended to Keokuk.

At Ottumwa, Iowa, on the Des Moines River, the ice broke up on February 12, a gorge formed north of Ottumwa causing a fall of 3 feet by the 19th, the river closing temporarily by the 19th and opening permanently on the 22d.

North of Keokuk the ice formed during the winter to the thickness of 24 inches, breaking up for a short distance above the dam by February 18, and by February 25 the ice was broken up far above the dam.—*Fred J. Gosewisch, Observer in Charge.*

Hannibal, Mo., river district.

The ice in the Mississippi River in this vicinity formed early, attained unusual thickness and broke up and passed out without doing any damage.

The first floating ice appeared at Hannibal on December 7 and the river became frozen above the Wabash bridge on December 9, without forming any gorge, worth mentioning. At this point the river continued frozen over until 4.45 a. m. February 16. People crossed the river on this ice as late as February 11.

Below the Wabash bridge the ice formed and extended out from the shores and closed about a mile below town on December 17. Most of this ice went out on December 20, but soon re-formed and by December 30 the river was entirely frozen over below as well as above the bridge, except a small air hole just below the bridge. Below the bridge, people crossed the river on the ice from December 30 to February 9. This ice broke up and moved out on February 14 and the ice above the bridge began moving out on February 16.

There was heavy floating ice in the river from February 16 to February 23, but from that time to March 6 only a little ice was observed.

The greatest thickness of ice observed was 17 inches on January 28. It probably was a little thicker during the first few days of February, but no measurements were obtained.

At other places in this river district the conditions were about the same as at Hannibal.—*B. L. Waldron, Meteorologist in Charge.*

Memphis, Tenn., river district.

The amount of ice passing through the Memphis district of the Mississippi River during the winter months of 1917–18, is believed to have been the greatest since the establishment of this station in 1871. Ice began moving past Memphis as early as December 13, 1917, and continued in varying amounts during most of the time until February 10, 1918. During December the river at times was nearly filled with moving ice, but not until the end of the month was there sufficient to interfere seriously with the movement of river craft, but on the 31st the ice became so heavy that only the largest boats attempted to run. Then on January 6, 1918, the ice gorged in a narrow stretch in the river near Richardson Landing about 50 miles above Memphis, causing a complete suspension of navigation to the north, but continued to southern points until January 17 when a portion of the Richardson gorge broke away, and this with the ice forming below the gorge filled the river from bank to bank, and on account of the low stage of water, a garge was formed about two miles below Memphis. For two or three days there was no movement in the ice at this place while the amount was constantly increasing from the flow from points above which, with the rapid increase in the water held back by the gorge, so increased the strain during the early morning of the 20th, that the gorge gave way and the whole mass moved out carrying with it four of the Lee Line steamers that were unable to reach a safe harbor on account of the ice congestion. Two of these steamers were crushed and sunk a few miles below Memphis while the remaining two were finally saved. Also a small steamer attached to the Mississippi River Commission fleet and one barge was sunk by the ice. From this time on to the end of January, 1918, only a moderate amount of ice passed Memphis as the Richardson gorge still held.

The Richardson Landing gorge extended a length of several miles, and at the point of formation reached from the river bed 4 to 10 feet above water level. At 12:30 p. m. February 4, 1918, this gorge gave way under the great pressure of added ice and water and seven hours later, about 7 p. m. the van of this ice gorge reached Memphis, filling the river from shore to shore with an immense mass of rough and jagged ice moving rapidly, some of the piled up cakes forming hummocks 10 to 15 feet in height. The Richardson Landing gorge held practically intact 29 days. On February 5, soon after midnight the great Osceola, Ark., gorge (see Fig. 8) that extended from a little below Osceola northward over 25 miles and first formed January 14, 1918—broke with a loud report that was heard for several miles. This ice reached Memphis at 9 a. m. and before noon the river was again filled with a turbulent mass of rapidly moving ice which imprisoned numerous small river craft, in all about 35 passing this station, some in perfect condition and some crushed and sin' ing. The craft passing here were: Twenty-one barges, a few laden but most of them empty; 2 wharf boats: 4 house boats: 1 dry-dock; 1 ferryboat; one pile driver; 1 tie loader; an unfinished hull of a steamer and a few others of undetermined character. The unfinished hull is said to have come from Paducah, Ky. It is thought that most of these craft were saved before reaching Helena as only a few passed that place. There were two barges loaded with logs, one of which was smashed on one of the bridge piers at Memphis, while the other passed on safely. Except the loss of the two Lee Line steamers and two small ones, the property of the Mississippi River Commission, there was no local loss or damage to river craft owned or controlled in the Memphis district. This was due to the fact that all local craft, except the fleet of Government dredge boats safely moored in their harbor below the two railroad bridges, were brought into the new canal that now passes in front of the city, an extension of Wolf River that formed a safe refuge against the moving ice and prevented the destruction of at least $600,000 worth of river craft. Total damage in this district $115,000.

The Weather Bureau records show that serious ice conditions prevailed in the Mississippi in this district during the winter of 1872–3, which at that time was said to have been the coldest and most severe winter in the last 30 years. On December 27, 1872, a gorge that had formed at Randolph, Tenn. (practically the same place as Richardson Landing where the gorge of this year occurred) broke and out of 20 steamers at the Memphis harbor, 8 were totally destroyed and 7 badly damaged. The Brown & Jones Coal Co. lost coal then valued at $150,000. On December 30, 1876, another gorge occurred at Randolph, Tenn., causing a suspension of navigation: and again in January, 1877, a gorge formed at the same place. In January, 1887, navigation was suspended for 10 days on account of ice gorges.—*S. C. Emery, Meteorologist in Charge.*

Vicksburg, Miss., river district.

Heavy floating ice began passing in the Mississippi River at Vicksburg during the night of January 20–21, 1918. On the 22d and 23d, the heavy ice was frozen together along each shore for about one-third of the way across, and the balance was moving. On the 24th, 25th, and 26th, the ice was all moving, and on the 27th, practically all had disappeared. Navigation was greatly impeded from January 21 to 25, inclusive. A little of the ice reached Natches, Miss., on January 24.

Heavy floating ice began passing on the night of February 9–10, and the flow of heavy ice practically ended during the night of 10–11. This was gorge ice from the Richardson and Osceola gorges above Memphis, Tenn. Navigation was impeded on the afternoon of February 10 by floating ice and débris.—*William E. Barron, Meteorologist in Charge.*

NORTHERN TRIBUTARIES OF OHIO AND LAKE ERIE DRAINAGE.

Wabash river district.

Ice formed in the river during the early days of December and by the 10th of the month the stream was frozen generally from source to mouth. Cold weather continued with very little interruption and by February 1 the ice was 13 to 14 inches thick in the extreme upper stream, 9 to 10 inches in the central portion, and 6 to 7 inches in the lower. After the first five days of February the weather became warmer, then thawing resulted, so that by the time the ice broke up, on February 12, it was from ½ to 1 inch less in the thicknesses than it was on the first of the month.

The ice broke up at Terre Haute, Ind., in the lower river late in the afternoon of February 11, but the general breaking up did not occur until the afternoon of February 12. On the morning of February 13 the stream was full of ice at all points. Gorging at some points occurred on the 13th and 14th, but this was slight and attended by little damage. In fact jamming and gorging did not reach a point where it caused any unusual concern; these conditions occurred in a much less degree than was anticipated.

By February 15 there was no ice in the upper river and this condition prevailed in the lower stream by the 19th. No ice was observed in the river at Terre Haute on the 17th and for 36 hours before there was only a small amount noticed.

In the upper stream in the vicinity of Bluffton a few shots of dynamite were used on February 11 and 12 with the view of protecting railroad and traction company bridges. No bridges were damaged, nor was any other material damage done, in the Wabash; a few small bridges that span some of the tributaries of the Wabash were damaged more or less, but no reliable information is available with respect to these.

It is estimated that $5,000 will cover all damage from ice in the entire valley.[1]—*W. P. Cade, Meteorologist in Charge.*

Fort Wayne, Ind., river district.

During the early part of December, 1917, the weather was specially favorable to the formation of ice, particularly between the 6th and 16th, and much ice formed during that period on the Maumee and its tributaries. Moderately high temperatures from December 19 to 24 resulted in considerable thawing and the ice lost considerably in thickness; but from the closing days of December, 1917, until February 5, 1918, the weather was unusually favorable to a rapid and substantial increase in the thickness of the ice cover. The ice attained its maximum thickness on February 4 or 5, and on these dates, except at Fort Wayne, where the Maumee did not freeze entirely across during the winter, the general thickness of the ice ranged from 20 to 25 inches.

[1] Conditions on White River in Indiana, were much similar to those on the Wabash.—*A. J. H.*